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Effect of Type of Milk and Storage Period on the Quality of Hard Cheese*

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Abstract: The objective of this study was to determine the effect of storage period on the chemical composition of hard cheese ("Roomi"), manufactured from cow and goat milks and their blends (1:1). A starter culture 1% of *Streptococcus thermophills* and *Lactobacillus bulugaricus* and rennet tablet (one tablet /50 litre milk) were used. The curd was cheddared, salted, moulded, pressed overnight, coated with paraffin wax and stored at 12±2ºC for ripening. The proximate analysis of cheeses reflected changes in total solids, total protein and fat contents towards ripening. Cheese prepared from goat milk recorded higher level of solids and fat than cow and blend cheeses. Cow cheese showed significantly ($P \leq 0.05$) higher level of protein than goat and blend cheeses. The pH of the three types of cheeses significantly ($P \leq 0.05$) decreased in concomitance with increase in their titratable acidity of all cheeses. The soluble nitrogen content increased significantly ($P \leq 0.05$) during ripening of all cheeses. The ratio of soluble nitrogen to total nitrogen also increased significantly ($P \leq 0.05$) during ripening of all cheeses.

Key words: Hard cheese; goat cheese; chemical composition; Sudan

INTRODUCTION

There are three types of Sudanese cheese; namely, "Gibna Beida" which is a soft white cheese made from milk, skimmed milk powder or recombined milk "Muddaffara" cheese which is a braided semi-hard cheese and the hard cheese, locally known as "Roomi".

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Earlier studies furnished information on biochemical properties of hard cheese made from cow milk during ripening (El-Abd *et al*. 1992; Jabbar *et al*. 2003; Pisano *et al.* 2006; Kongo *et al*. 2009). Lau *et al.* (1991) reported that the increase in titratable acidity is slightly correlated with an increase of cheese proteolysis during aging of cheddar cheese. Hort *et al.* (1997) concluded that as pH decreases, the breakdown of the protein network increases which gives rise to a variety of textures within small pH range**.** Mas *et al*. (2002) found that the total solids in the Ibores goat cheese increased gradually reaching 59.9% by 60 days. Jabbar *et al.* (2003) observed progressive increase in the fat content of wax coated Gouda cheese during storage. Dervisoglu and Aydemir (2007) reported that the total solids contents in Kulek Turkish hard cheese manufactured from cow milk showed a significant increase throughout the ripening period (120 days). Kongo *et al*. (2009) also reported the increase in total protein from 19 to 26% of the Sao-Jorge cheese manufactured from cow milk.

In the Sudan, Mohammed and Abdel-Razig (2006) studied the effect of coating material on the quality of hard cheese. No attempts were made to use goat milk in making hard cheese in the Sudan. So the objective of this study was to determine the effect of storage period on the chemical composition of hard cheese ("Roomi") manufactured from cow and goat milks and their blends (1:1).

MATERIALS AND METHODS

Cheese making

Fresh cow milk and fresh goat milk were obtained from a private farm and a center for goat reproduction (Khartoum North), respectively. Hard cheese was made according to the method described by Fox *et al*. (2004). Fresh milk of cow, goat and a blend of both (1:1) were pasteurized at 72ºC for one minute and cooled to 32°C; 1% starter culture of *Streptococcus thermophills* and *Lactobacillus bulugaricus* (1:1) and a rennet tablet (one tablet/50 litre milk), dissolved in cold water, were added.

The curd was collected in half an hour, heated to 40°C and stirred to become firm and elastic and then re-heated to 45ºC for another hour before draining off the whey using cheese cloth to yield a cohesive mass. A salt 2% (curd weight) was added, curd pieces were moulded, pressed overnight before coating the cheese blocks with paraffin wax and storing at 12±2ºC for 6 months for ripening.

Chemical analysis of cheese

Total solids and fat content of cheese were determined by the AOAC (1990) method. Total nitrogen and soluble nitrogen were assessed by the micro-Kjeldhal method, according to Ling (1963). The pH was determined, as described by Newlander and Atherton (1964), using a pH meter (Model L.pusl Muchen 15–1260/7, Germany). The titratable acidity was determined, according to the AOAC (1990) method.

Statistical analysis

The data were subjected to statistical analysis system using one factor complete randomized design. Means were separated using Duncan's Multiple Range Test.

RESULTS AND DISCUSSION

Total solids (TS) significantly ($P \leq 0.05$) increased in hard cheese during storage (Table 1) suggesting gradual loss of cheese moisture (Jabbar *et al*. 2003) towards maturity. Hard cheese prepared from goat milk yielded higher TS (71.93%) after 6 months than those prepared from cow milk and the mixture of both milks. It seems that the coating material has affected extent of loss of moisture in Sudanese hard cheese (Mohammed and Abdel Razig 2006). Pisano *et al*. (2006) showed that the significant ($P \leq 0.05$) loss in humidity is accompanied by continuous increase in TS in Firo- Sardo traditional hard cheese manufactured from cow milk.

The protein in hard cheese significantly ($P \leq 0.05$) increased (Table 1). The level of protein content in goat and blend cheeses is more or less similar (25.01%–25.05%), but cow cheese protein gave significantly ($P \leq 0.05$) higher level. This result agrees with the findings of Jabbar *et al*. (2003),

Mohammed and Abdel Razig (2006), Faccia *et al.* (2007), Dervisoglu and Aydemir (2007) and Kongo *et al*. (2009). The increase in protein content of hard cheese is attributed to the direct loss in moisture.

The fat content increased significantly ($P \leq 0.05$) as the storage progressed in the three types of cheese (Table 1). The fat content in goat cheese was higher than cow and blend cheeses. This finding agrees with Jabbar *et al*. (2003) who reported the increase of fat content in wax coated Gouda cheese, and Mohammed and Abdel Razig (2006) also found that the fat content increased during storage in ("Roomi") hard cheese. Again, increase in fat content of hard cheese is attributed to loss in moisture of cheese during storage. Level of fat in matured cheese is mainly attributed to amount of fat retained by the curd during cheese making. This would suggest higher retention of goat milk casein. The higher fat level in goat milk cheese (34.05%) after 6 months improves its calorific value, yet cow / goat milk blend cheese may be suitable for special dietary purposes being significantly ($P \leq 0.05$) lower in fat.

The soluble nitrogen (SN) in cheese increased significantly ($P \leq 0.05$) in the three types of cheeses during the ripening process (Table 2). The SN of cow milk cheese increased from 0.18% at day one to 0.51% in 180 days of storage compared with 0.24% and 0.57% in goat cheese,. Kucukorer and Haque (2003) reported increase in the SN of waxed Edam cheese during progressive ripening. Mohammed and Abdel Razig (2006) also reported increase in SN coated with paraffin and bee wax during storage. The higher level of SN in the goat cheese may be due to the more proteolytic activity in goat milk proteases (El-Abd *et al.* 1992).

The degree of ripening of cheese is expressed as soluble nitrogen / total nitrogen (TN) ratio. The calculated ratio of SN/TN was higher in the blend cheese and goat cheese than in cow cheese (Table 2), reflecting accelerated cheese ripening in milk blend and goat cheeses. In the three types of cheeses, SN/TN showed a marked increase during the storage. These results agree with the findings of Gouda *et al*. (1992) and Mohamed *et al.* (1992) who reported that soluble nitrogen to total nitrogen ratio of Ras cheese coated with paraffin wax increased during ripening. The ripening indices for blend and goat cheese were higher than

the cow cheese which could be attributed to the relatively more rapid casein degradation in the blend and goat cheese (Shendy 1989).

There was significant decrease ($P \leq 0.05$) in pH values coupled with an increase in titratable acidity of the three types of cheese as ripening period progressed (Table 3). A similar result was obtained by Gouda *et al*. (1992) and Mohamed *et al.* (1992) who found that there was an increase in the titratable acidity of Ras cheese coated with paraffin during ripening. However, a decrease in the pH of hard cheese during ripening has been reported (Watkinson *et al*. 1997; Kosikowski and Mistry 1997; Simov and Ivanov 2005). In the Sudan, Mohammed and Abdel Razig (2006) found that titratable acidity of Sudanese hard cheese was increased in samples coated with paraffin and bee wax during storage.

Ihekoronye and Ngoddy (1985) reported long before that the increase in titratable acidity is attributed to the enzymatic hydrolysis of cheese fat during cheese ripening. Nelson and Barbano (2005) concluded that the increase in the titratable acidity of cheeses is correlated with the increase of cheese proteolysis during aging in Cheddar cheese. Similar conclusion was reached by Pisano *et al*. (2006) in Fiore Sardo hard cheese.

In conclusion, goat milk alone or blended with cow milk can be successfully used to prepare hard cheese.

Table 1.Changes in total solids and protein and fat percentages of hard cheese during storage

Storage period (days)	Cow milk cheese	Goat milk cheese	Cow/goat milk blend (1:1)cheese
	Total solids (%)		
1	60.38^{f}	60.81^{g}	59.01^{h}
60	62.67^{e}	64.01^{d}	61.28^{e}
120	64.88^{c}	67.08^{b}	63.40^{d}
180	67.04^{b}	71.93^{a}	66.90^{b}
	Total protein (%)		
1	24.42^{e}	24.13^{f}	24.11^{d}
60	25.22^{b}	24.31^{d}	24.99^{c}
120	25.24^{b}	24.78^{c}	25.00^{c}
180	25.38^{a}	25.05^{c}	25.01^{c}
	Fat content (%)		
1	26.5^{i}	28.5^{h}	26.0^{i}
60	29.5^{g}	32.2^{b}	28.0^{h}
120	30.9^{d}	32.95^{b}	29.4^{f}
180	32. 1^{c}	34.05^{a}	29.9^{e}

Means bearing different superscript letters in columns and rows for each parameter are significantly different at P=0.05, according to the Duncan's multiple range test.

Table 2. Changes in the percentages of soluble nitrogen and soluble nitrogen/ total nitrogen of hard cheese during storage

Storage period (days)	Cow milk cheese	Goat milk cheese	Cow/goat milk blend (1:1)cheese
	Soluble nitrogen (%)		
1	0.18^{k}	0.24^{i}	0.20^{j}
60	0.20^{h}	0.46^{f}	0.24^{i}
120	0.40^{g}	0.50^{d}	0.48^{e}
180	0.510^{c}	0.57^{a}	0.53^{b}
	Soluble nitrogen/ total nitrogen (%)		
1	4.62^{h}	5.42^{g}	5.10^{g}
60	5.21^{g}	9.32^{de}	5.21^{g}
120	8.77^{f}	9.62^{cd}	9.78^{bc}
180	9.14^{e}	10.09^{ab}	10.18^{a}

Means bearing different superscript letters in columns and rows are significantly different at P=0.05, according to the Duncan's multiple range test.

Table 3. Changes in pH and titratable acidity of hard cheese during storage

Storage period (days)	Cow milk cheese		Goat milk cheese		Cow/goat blend milk cheese(1:1)	
	pH	Titratable acidity (%lactic acid)	pH	Titratable acidity (%lactic acid)	pH	Titratable acidity (%lactic acid)
1	5.55^{b}	1.60^{e}	5.76^{a}	1.46^{f}	5.41^{c}	1.46^{f}
60	5.35^{e}	1.78^{d}	5.37^{d}	1.82^{cd}	5.19^{i}	1.82^{cd}
120	5.29^{f}	1.82^{cd}	5.25^{g}	1.88^{c}	5.14^{j}	1.88^{c}
180	5.10^{k}	2.13^{a}	5.02^{h}	2.02^{b}	5.01^{l}	2.02^{b}

Means bearing different superscript letters in columns and rows for each attribute of pH values and titratable acidity are significantly different at P=0.05, according to the Duncan's multiple range test.

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تاثير نوع اللبن وفترة التخزين على جودة اصناف الجبن الجاف*

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المستخلص : هدفت هذة الدراسة الي معرفة تأثير فترة التخزين علي التركيب الكيميائي للجبن الجاف (الرومى) المصنع من لبن البقر و لبن الماعز وخليط منهما بنسبة 1:1. أستخدم البادىء (1%) *Streptococcus thermophilus* و *Lactobacillus bulgaricus* وحبوب التجبن (حبة/50 لتر لبن)، وبعد تكوين الخثرة تم طبخها وأضيف الملح ووضعت في قوالب وضغطت لمدة 24 ساعه ، وغلفت بشمع البرافين و خزنت في درجة حرارة 12 ± 2^0 م للنضج. أظهر التحليل التقريبي للجبن تغيرا فى المواد الصلبة الكلية والدهون والبروتين الكلي اثناء النضج . سجل الجبن المصنوع من لبن الماعز أعلى نسبة للمواد الصلبة و الدهن مقارنة بجبن البقر والجبن المصنع من خليط من لبن البقر والماعز. اظهر جبن البقر اعلى نسبة للبروتين مقارنة بجبن الماعز وجبن الخليط. تناقص الرقم الهايدروجينى معنويا فى أنواع الجبن الثلاثة . زاد النيتروجين الذائب معنويا خلال فترة النضج في انواع الجبن الثلاثة.

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